PATENT SPECIFICATION

788,150

Date of Application and filing Complete Specification: Aug. 23, 1956.

No. 25737/56.

Complete Specification Published: Dec. 23, 1957.

Index at acceptance:—Class 83(4), Z.

International Classification:—B21d.

COMPLETE SPECIFICATION

Process of and Tool for Expanding Tube Ends

We, BABCOCK & WILCOX LIMITED, a British Company, of Babcock House, Farringdon Street, London, E.C.4, do hereby declare the invention, (Communicated by DEUTSCHE BABCOCK & WILCOX DAMPFKESSELWERKE A/G, a German Company, of Oberhausen, Rhineland, Germany), for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to a process of and tool for expanding tube ends, applicable for example to the attachment of water tubes to the steam and water drum of a water tube boiler.

It is common practice to secure the ends of water tubes to a boiler drum by fitting each tube end within a tube hole in the drum and then expanding plastically the tube end within the tube hole, so that it remains firmly in contact with the wall of the hole to provide a fluid-tight joint. In order to improve the resistance to the tendency of the tube, when the boiler is in use, to pull out of the drum, the part of the tube projecting into the drum is often belled out.

Several different methods of obtaining the desired expansion have been used. According to one method, a tool is used which includes a conical mandrel about which are spaced three corresponding tapered rollers, the tool being inserted in the tube end to be expanded with the axis of the mandrel co-axial with the tube end and the mandrel being fed into the tube independently of the rollers so that the rollers are displaced outwardly into contact with the inner surface of the tube. The mandrel is then continuously rotated and the rollers are forced outwardly to expand the tube end and at the same time roll progressively round and into the tube. It has been found that with this method of expanding there is a tendency for each point of the tube wall, after each passage of a roller has caused an expansion, to spring back elastically and thereby considerably reduce the contact pressure between the tube wall and the wall of the tube hole. Furthermore, the structure of the tube metal is affected, the metal becoming hardened by the alternating load.

According to a second rather similar method, the tube is expanded by a tool having a tapered mandrel and rollers in which the mandrel and the rollers rotate and move outwardly towards the end of the tube during the expanding operation.

According to a third method, a mandrel with a working surface having a diameter slightly greater than the inside diameter of the tube is driven into the tube end, so expanding the tube as it moves into it. This method has certain practical difficulties when applied to long thin tubes, which tend to buckle, and the removal of the mandrel from the tube after the expanding operation often gives much trouble.

An object of the present invention is the provision of an improved method of and tool for expanding tube ends.

The invention includes the process for the securing of a tube end within a tube hole in a tube plate, which comprises expanding a part of the tube into fluid-tight contact with the wall of the tube hole by the forcible pulling-out of a tube expanding member through the said part of the tube end and simultaneously as a consequence of the pulling-out effecting belling of the mouth of the free end of the tube into contact with the face of the tube plate.

The invention also includes a tube end expanding tool suitable for the expanding of a tube end within a tube hole in a tube plate in which withdrawal means are provided for the forcible pulling-out from inside the tube end of tube expanding means adapted during withdrawal to expand the part of the tube within the tube hole, and the withdrawal means are arranged during withdrawal to operate belling means which effect belling of the free end of the tube.

The invention will now be described, by way of example, with reference to the accom-

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panying partly diagrammatic drawings, in which:—

Figure 1 is a sectional side elevation of the forward end only of a tool for expanding and belling tube ends arranged to operate on a tube end that extends through a tube plate; and

Figure 2 is a view similar to Figure 1 but with the working parts in a different operating position.

In the drawings, a tube 1 extends through a tube hole 2 in a tube plate 3 with its inner end 4 projecting beyond the inner face 5 of the tube plate to a distance equal to about twice the wall thickness of the tube. The tool, indicated generally by 10, includes a forward body part 11 terminating in a bearing surface 12 which, when the machine is in use, is held firmly against the part of tube plate inner face 5 which surrounds the tube end 4. A mandrel 14 mounted in the body part 11 extends axially beyond the bearing surface 12 and at the commencement of the expanding operation lies in the initial position shown in Figure 1 in which it extends into the tube 1 to a point beyond the tube plate 3. At its inward or forward end the mandrel 14 is formed with an enlargement or head 15 adjoining a part 16 that tapers rearwardly to a cylindrical part 17 beyond which a part 18 of the mandrel is screw-threaded into an operating rod 19 which is coupled to the piston of an hydraulic power device (not shown).

A group of four complementary expanding members 21 are slidably mounted on the tapered mandrel part 16 and may be moved from the aligned position shown in Figure 2, in which aligned parts thereof form a complete ring-like tube expanding surface 22, to a staggered position shown in Figure 1 in which one opposed pair of the members 21 is offset rearwardly of the other pair so that the overall radius of each member is reduced. The four members 21 are held together and to the mandrel by a helical spring 24 that encircles part-cylindrical sections 25 of the four members.

Slidably mounted on the cylindrical part 17 of the mandrel is a movable stop 30 in the form of a tube length having a cylindrical rearward portion 31 which is a sliding fit on the mandrel part 17 and a flared forward part 32 of such diameter at its forward end that it engages the two rearmost expanding members 21 when they are at the rearward end of the tapered part 16 of the mandrel. Secured to the rearward end of the portion 31 is a boss 33 formed with a circumferentially extending radial shoulder 34 that faces rearwardly of the mandrel. Mounted on the body part 11 are catch means in the form of four plungers such as the plungers 36 so arranged as to be slidable radially and being biassed inwardly by springs such as springs 37. These plungers are arranged to engage the boss 33 and are so shaped at their inward ends that they restrain rearward movement of the shoulder 34 past the plungers only until the axial force on the stop 30 exceeds some predetermined value.

Also mounted on the body part 11 is a circular row of eight tube end belling elements 40 so guided in the body part 11 as to be capable of radial movement only and biassed by springs such as springs 41 inwardly into engagement with the stop 30. The inner side of each element 40 is provided with an inclined surface 42 complementary to the flared forward part 32 of the stop 30 so that as the part 32 moves rearwardly past the elements 40 they are moved outwards in a radial direction. Each element 40 is formed with a forwardly extending tongue 44 arranged to extend within the tube end 4 but of such length that its forward end is spaced from the tube plate face 5 by a distance somewhat greater than the thickness of the wall of the tube 1.

To carry out the expanding operation, the tool 10 is brought into position opposite the tube end to be expanded and the mandrel 14 inserted into the tube to the position shown in Figure 1, so that the bearing surface 12 engages the tube plate face 5, the stop 30 being set with its shoulder 34 forwardly of the plungers 36, the expanding members 21 being towards the rearward end of the tapered part 16 of the mandrel 14 and the rearmost pair of the members 21 being in contact with the forward end of the stop 30.

The mandrel 14 is now drawn rearwardly through the tool body part 11 by operation of the hydraulic power device so that the expanding members 21, which are held against axial movement with the mandrel 14 by the stop 30, are caused to move outwardly into contact with and to expand the part of tube 1 which lies immediately outside the tube plate 3. As this takes place the forward pair of the members 21 move slightly rearwardly into alignment with the other pair of the members 21.

Once the head 15 of the mandrel 14 comes into contact with the expanding members 21 force is transmitted directly from the mandrel to the stop, which is caused to move in a rearward direction so that the plungers 36 of the catch means ride over the shoulder 34. The expanding members 21 and the stop 30 move rearwardly with the mandrel, the members 21 effecting progressive expanding of the part of the tube 1 which lies within the tube plate 3.

As the members 21 approach the inner face 5 of the tube plate 3 the flared part 32 of the stop member 30 engages the inclined surfaces 42 upon the eight belling elements 40 and causes those elements to move outwardly radially so that their tongues 44 engage and bell outwardly the projecting inner end 4 of

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the tube 1. This belling operation ends when the tube expanding surface 22 comes into contact with the forward part of the surfaces 42, whereupon rearward movement of the mandrel relative to the tool 10 is positively checked.

The tool 10 is now removed from the finished tube, the mandrel returned to its forward position, the tube expanding elements 21 slid along the tapered part 16 to their rearward positions, and the stop 30 restored to its forward position. The tool may then be applied to the next tube to be expanded.

The machine described is adapted to act upon a preselected size of tube, the diameter of the expanding surface 22 being appropriately related to the internal diameter of the tube. If desired the head 15 of the mandrel may be made adjustable axially of the mandrel 14; it then serves as a stop adapted by limiting movement of the expanding members axially of the tapered part of the mandrel to determine the effective diameter of the expanding members during the expanding operation, and the position of the stop being adjustable permits variation of that effective diameter. When the head 15 is axially adjustable, it is advantageous to adopt a piston-ring shaped, overlapping design for the expanding members.

What we claim is:—

1. Process for the securing of a tube end within a tube hole in the tube plate, which comprises expanding a part of the tube into fluid-tight contact with the wall of the tube hole by the forcible pulling-out of a tube expanding member through the said part of the tube and simultaneously as a consequence of the pulling-out effecting belling of the mouth of the free end of the tube into contact with the face of the tube plate.

2. A tube end expanding tool suitable for the expanding of a tube end within a tube hole in a tube plate, wherein withdrawal means are provided for the forcible pulling-out from inside the tube end of tube expanding means adapted during withdrawal to expand the part of the tube within the tube hole, and the withdrawal means are arranged during withdrawal to operate belling means which effect belling of the free end of the tube.

3. A tool as claimed in Claim 2, wherein the belling means comprise a circular row of tube end engaging elements which are arranged to move radially outwardly upon withdrawal of the tube expanding means and so effect belling of the tube end.

4. A tool as claimed in Claim 3, wherein the tube expanding means include a plurality of expanding members fitted about the periphery of a tapered part of the length of a mandrel which is insertable axially into the tube to be expanded and forms part of the withdrawal means, stop means are arranged to lie within the tube to be expanded at a forward initial position, catch means are arranged to restrain outward movement of the stop means from the initial position unless the outward force on the stop means exceeds a predetermined value, the stop means being arranged to restrain outward axial movement of the said members upon outward movement of the mandrel only until the force exerted exceeds the predetermined value, and the tube end engaging elements are arranged for engagement by inclined surfaces on the stop means whereby upon the mandrel moving the expanding means and thus the stop means in an outward direction through an appropriate distance a part of the tube that extends beyond the tube plate is engaged and belled out by the belling means.

5. A tool as claimed in Claim 4, wherein the expanding members are held in close contact with the tapered part of the mandrel by a circumscribing spring.

6. A tool as claimed in Claim 4 or Claim 5, wherein a stop provided on the mandrel is adapted by limiting movement of the expanding members axially of the tapered part of the mandrel to determine the effective diameter of the expanding members during the expanding operation, and the position of the stop is adjustable to permit variation of that effective diameter.

7. A tube end expanding tool arranged and adapted to operate substantially as described hereinbefore with reference to, and constructed substantially as shown in, the accompanying drawings.

For the Applicants.
A. C. PRIOR,
Chartered Patent Agent.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1957.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

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1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

FIG. 1.

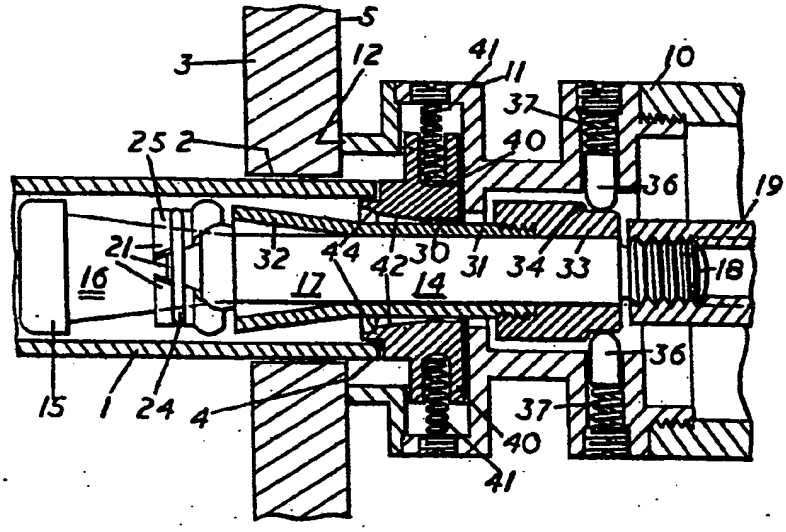
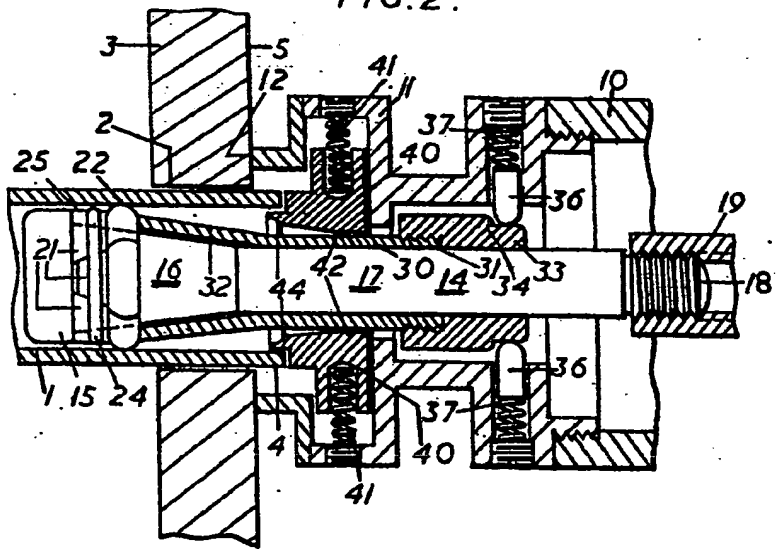


FIG. 2.



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